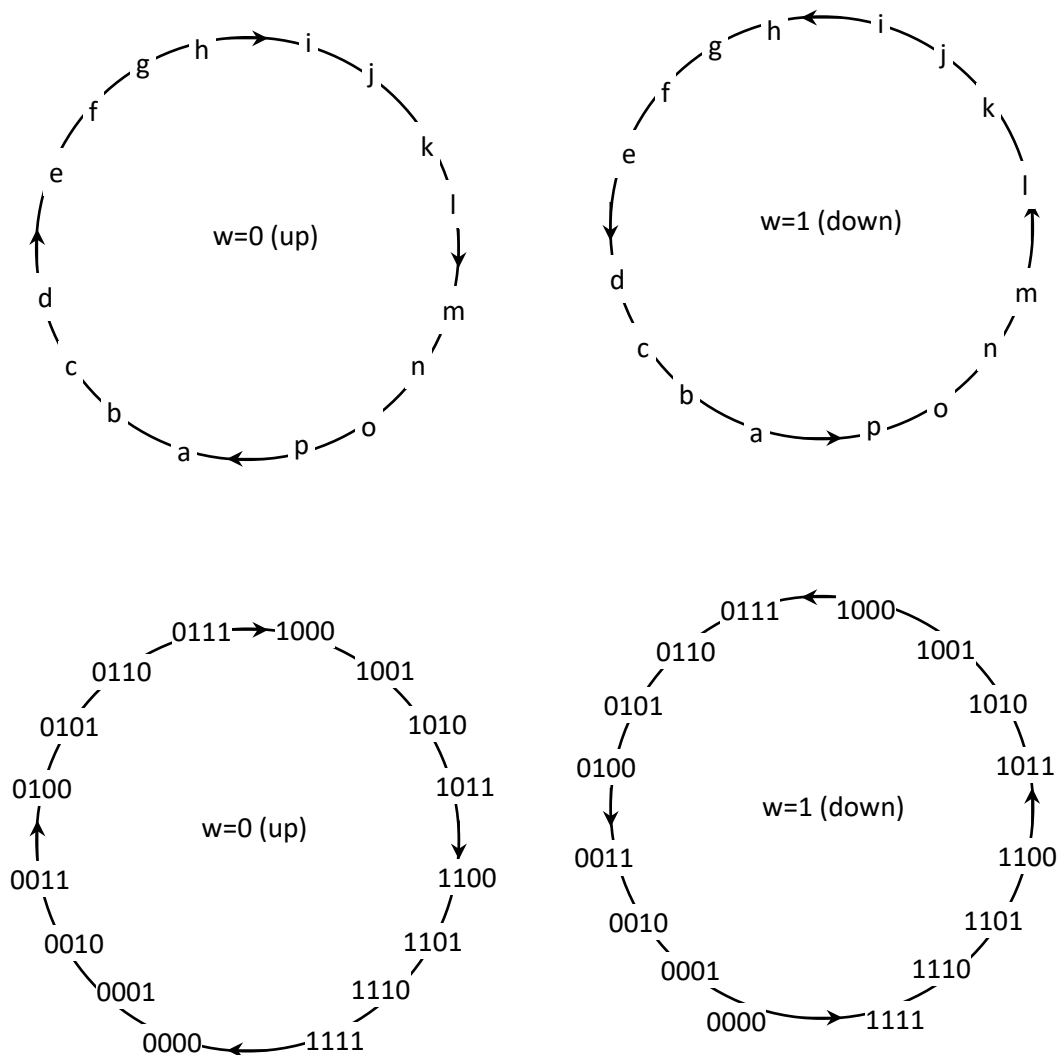




**2020 Fall - ECE 2220 Laboratory 8: A Finite-State Machine – Up/Down Counter**

**Instructions**

- 1) Design a finite-state machine to generate the following sequence where the outputs and next state are dependent upon **both the state of the circuit and the inputs**. This is an up/down counter where the input ( $w$ ) determines the direction of the counter. As show in the figure below, if the input,  $w=0$ , the sequence goes clockwise and if  $w=1$ , the sequence goes counter clockwise. The sequence just demonstrates a simple 4-bit up down counter.



- a) Create a **state table** for this finite state machine for the up/down counter.

[illegible]

- b) Explain how you could implement the same circuit with D flip-flops

Clock	D	Q(t+1)
0	0	Q
1	0	0
1	1	1

## State assignment

[illegible]

D3(w=0)		d1 d0			
d3 d2		0 0	0 1	1 1	1 0
0 0					
0 1					
1 1					
1 0					

D3(w=1)		d1 d0			
d3 d2		0 0	0 1	1 1	1 0
0 0					
0 1					
1 1					
1 0					

D3 = \_\_\_\_\_

D2(w=0)		d1 d0			
d3 d2		0 0	0 1	1 1	1 0
0 0					
0 1					
1 1					
1 0					

D2(w=1)		d1 d0			
d3 d2		0 0	0 1	1 1	1 0
0 0					
0 1					
1 1					
1 0					

D2 = \_\_\_\_\_

D1(w=0)		d1 d0			
d3 d2		0 0	0 1	1 1	1 0
0 0					
0 1					
1 1					
1 0					

D1(w=1)		d1 d0			
d3 d2		0 0	0 1	1 1	1 0
0 0					
0 1					
1 1					
1 0					

D1 = \_\_\_\_\_

D0(w=0)		d1 d0			
d3 d2		0 0	0 1	1 1	1 0
0 0					
0 1					
1 1					
1 0					

D0(w=1)		d1 d0			
d3 d2		0 0	0 1	1 1	1 0
0 0					
0 1					
1 1					
1 0					

D0 = \_\_\_\_\_

Using the any of the **internal clocks**, add a clock into your code such that the counter will count up or down at a 1 second interval. You will need to write a **separate module for this**. Use **SW[0] to control the direction (up/down) of the counter** and **SW[9] as a reset which puts the counter back to zero**. Use one of the **LEDS in the middle show the state of the slow clock**. Use **the 1<sup>st</sup> and last LED to show the state of w and reset**. Use one of the **seven-segment displays to show the hexadecimal state of the machine**. LEDs can be used to confirm the binary count and the slower clock. You may implement this counter using the D-latches as before or with some other "more efficient" code. Simulate the code and show it is working on the DE10 board.